Intern. J. Neuroscience, Vol. 88, pp. 243–247
Reprints available directly from the publisher
Photocopying permitted by license only

© 1996 OPA (Overseas Publishers Association)
Amsterdam B. V. Published in The Netherlands under license by
Gordon and Breach Science Publishers
Printed in Malaysia

BRIEF COMMUNICATION: INCREASES IN GEOMAGNETIC ACTIVITY ARE ASSOCIATED WITH INCREASES IN THYROXINE LEVELS IN A SINGLE PATIENT: IMPLICATIONS FOR MELATONIN LEVELS

R. P. O'CONNOR and M. A. PERSINGER*

Behavioral Neuroscience Program, Laurentian University, Sudbury, Ontario, Canada, P3E 2C6

(Received in final form 15 August 1996)

Blood levels of free T4 (thyroxine), cortisol and prolactin over 19 successive days from a single limbic epileptic patient were correlated with daily geomagnetic activity (aa values) for the northern hemisphere. Only thyroxine levels were correlated (r = 0.66) significantly with the daily geomagnetic activity; the strongest association (rho = 0.76) occurred between thyroxine levels and the geomagnetic activity (Kp values) during the previous night (2:00 A.M. to 5:00 A.M. local time). These results support the hypothesis that suppression of (nocturnal) melatonin levels by increased geomagnetic activity attenuates the tonic inhibition by this pineal compound upon thyroidal metabolism.

Keywords: Geomagnetic activity; thyroxine; epilepsy; melatonin

INTRODUCTION

Increases in global geomagnetic activity have been hypothesized to evoke suppressions in circulating (nocturnal) melatonin levels or the synthesis of melatonin within the pineal organ (Persinger, 1995*a*, *b*). To our knowledge direct comparisons between daily levels of melatonin and daily geomagnetic activity have not been published. However concentrations of thyroxine within the blood are frequently monitored in some patients. Because pinealectomies are

*Corresponding author. Fax: 705-675-4889. E-mail: F1200002@nickel.laurentian.ca.

associated with increased thyroxine levels and injections of melatonin suppress the release of thyroid stimulating hormone within one hour (Relkin, 1972; 1978), we reasoned that circulating thyroxine could be used as an inference of alterations in geomagnetically-induced suppressions of circulating melatonin in a specific clinical subpopulation who exhibit limbic epilepsy. If the proposed relationship between increased geomagnetic activity, decreased melatonin levels and increased thyroxine were valid then there should be a moderately strong, positive correlation between daily geomagnetic activity and thyroxine for these patients.

MATERIALS AND METHODS

The patient was a 34 year old woman who had displayed complex partial seizures for more than 10 years. Despite multiple and different medications during this period, absences, automatisms and myoclonic (usually lateralized to the left side) seizures ranged between 0 and 5 per day. In order to discern possible endocrine correlates to these episodes, she was admitted for 20 days to hospital. At that time the primary medications were Phenobarbitol (30 mg/day) and sertraline (Zoloft) (150 mg/day). Daily (collected in the morning) blood measures during this time were analyzed for thyroxine, prolactin and cortisol by routine laboratory procedures. Global geomagnetic activity, as inferred by the provisional aa values of Mayaud (see Persinger, 1995a for description), were obtained for the northern hemisphere from the Geomagnetic Indices Bulletin (National Geophysical Data Center, Broadway, Boulder, Co., U.S.A.). To discern if geomagnetic activity during the previous night (when melatonin levels would be highest) affected thyroxine levels the next day, the 8, 3-hr Kp values were also obtained from this bulletin.

Both nonparametric (Spearman) and parametric (Pearson) correlations were completed between the daily geomagnetic activity (measured in nanoT), and the levels of thyroxine, prolactin and cortisol. Similar analyses were completed between the 3 hr Kp values and these measures. Lag analysis was completed for each of the three days before the base days between each variable and each of the remaining variables. Symmetrical partial correlations were computed for the lags of these variables and their base values to discern the source of any association. Multiple regression analysis was implemented between thyroxine levels (dependent variable) and for the aa values on the same and for each of the previous three days to reveal any recondite effects. All analysis involved SPSS software on a VAX 4000 computer.

RESULTS

The means and standard deviations for the four measures during the 19 successive days for the different measures were: free T4 or thyroxine 11.2 (1.3) pmole/L, cortisol 544 (141) nmole/L, prolactin 19.5 (7.6) microg/L and aa values 21.4 (12.3) nT. The only statistically significant ($p < .01$) zero order correlation ($r = 0.66$; *rho* = 0.59) occurred between geomagnetic activity and the levels of thyroxine on the same days (no lags). Figure 1 shows this relationship.

The correlations between daily thyroxine levels and geomagnetic activity for each of the three days before the measures were 0.49, 0.55 and 0.18 respectively. Partial correlation analyses indicated that whereas the significant correlation between thyroxine levels and geomagnetic activity on the same days was not altered when the shared variance with geomagnetic activity during each of the three days before the measurement was held constant, the associations between

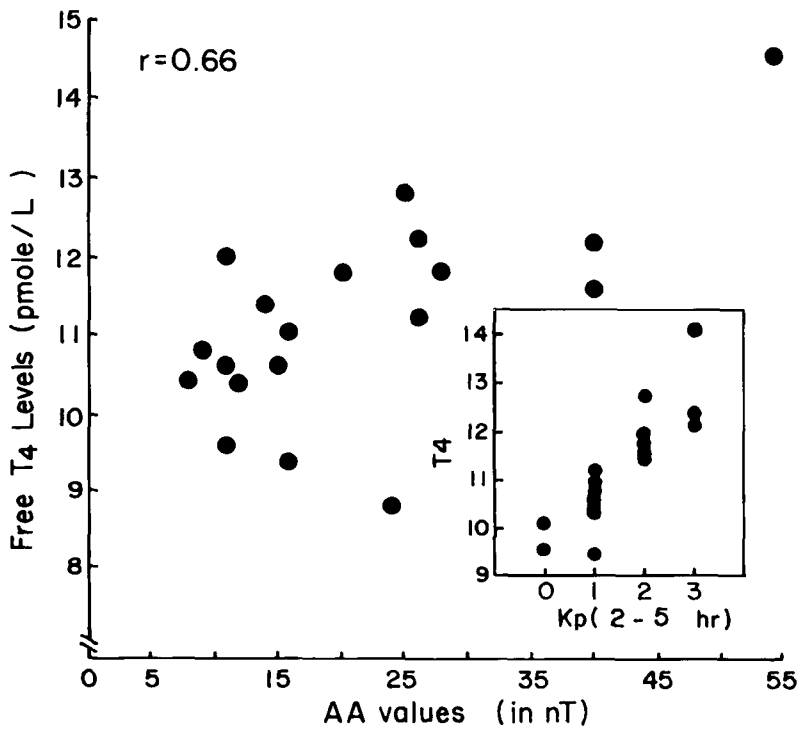

FIGURE 1 Concentrations of unbound T4 (thyroxine) levels (pmoles/L) in a patient and the daily geomagnetic activity (in nanoT) within the northern hemisphere (provisional aa values). Insert shows association between Kp values between 0200 hr and 0500 hr local time (previous night) and T4 levels.

thyroxine levels and the lagged values for geomagnetic activity were no longer significant statistically if the correlation between thyroxine and geomagnetic activity on the same day was first removed. The serial correlations between time (days) and geomagnetic activity or thyroxine levels were not significant (rs = 0.06, −0.05, respectively).

The correlations (r) between geomagnetic activity and thyroxine levels for each of the three days before were 0.59, 0.25 and −0.15, respectively. Whereas the correlation between aa values and thyroxine levels the days before was no longer significant if the shared variance with thyroxine levels on the same day as the geomagnetic measures was first removed, the partial correlation ($r = 0.56$) for aa values and thyroxine on the same days (after the values for the previous day were held constant) remained statistically significant. The Spearman rho correlations between thyroxine levels and each of the 8, 3 Kp measures were: Kp1 = 0.42, Kp2 = 0.75, Kp3 = 0.76, Kp4 = 0.58, Kp5 = 0.47, Kp6 = 0.29, Kp7 = 0.50 and Kp8 = 0.37. Only the values for Kp2 and 3 (equivalent to local time 11 P.M. to 01:59 A.M. and 2:00 A.M. to 4:59 A.M.) exceeded $p < .001$.

DISCUSSION

These results, which represent a moderately strong positive association between ambient geomagnetic activity and thyroxine over 19 successive days supported our hypothesis: geomagnetic activity is associated with enhanced thyroxine levels because some variable associated with the scalar value for this geophysical stimulus inhibits melatonin's tonic inhibition of thyroidal metabolism (Quay, 1974). The hypothesis is an extension of the premise that if the pineal gland inhibits tissue of ectodermic origin (e.g., the thyroid), then pineal chemistry should inhibit the endogenous chemistry of these tissues. Experimental data suggest that switches in the polarity of weak magnetic fields might decrease inhibitory effects of melatonin upon TSH (thyroid stimulating hormone) by direct effects upon the serotonin N-acetyltransferase (Yaga *et al.*, 1993).

However interactions with other endocrine chemistry may mask the relationship. For example, inspection of Figure 1 suggested that the thyroxine level on a day when aa values were about 25 was below the predicted value. Regression analysis verified that the value for this day was the *only* outlier (standardized residual = −2.6). It may be of interest that on this day the patient's cortisol level was 787 nmole/L, i.e., more than 1.5 SD above the mean of the remaining days [530 (131) nmole/L] and that cortisol is known to suppress thyroxine levels (van Cauter, 1989). When this single day was removed, the correlation between thyroxine levels and daily aa values = 0.82; the Spearman rhos between T4 and

Kp2 and Kp3 were 0.83 and 0.91. The possibility that association between thyroxine levels and the ambient nocturnal fields was secondary to a shift in circadian rhythms (Sandyk, Anninos & Tsagas, 1991; Sandyk & Anninos, 1992) cannot be excluded at this time.

Although the sample size was small we applied Bureau and Persinger's method (1995) for determining the limen or threshold for an effect. The most significant threshold was estimated between 20 and 25 nT. A similar threshold was found for reduced seizure onset times for rats (Bureau & Persinger, 1995) the report of dissociative experiences by humans (Persinger, 1995*b*) and the experience of vestibular (body) by volunteers who were placed within partial sensory deprivation (Persinger & Richards, 1995). The possibility that the specific association between geomagnetic activity-melatonin levels and thyroxine may only be evident within electrically labile brains cannot be excluded at this time.

Acknowledgements

Thanks to Dr. G. N. Xidos for his contribution and to the patient for her continued cooperation in our pursuit to stop her seizures.

References

Bureau, Y. R. J. & Persinger, M. A. (1995) "Decreased latencies for limbic seizures induced in rats by lithium-pilocarpine occur when daily average geomagnetic activity exceeds 20 nT", *Neuroscience Letters*, **192**, 142–144.

Persinger, M. A. (1995*a*) "Sudden unexpected death in epileptics following sudden, intense increases in geomagnetic activity: prevalence of effect and potential mechanism", *International Journal of Biometeorology*, **38**, 180–187.

Persinger, M. A. (1995*b*) "Out-of-body-like experiences are more probable in people with elevated complex partial epileptic-like signs during periods of enhanced geomagnetic activity: a nonlinear effect", *Perceptual and Motor Skills*, **80**, 563–569.

Persinger, M. A. & Richards, P. M. (1995) "Vestibular experiences of humans during brief periods of partial sensory deprivation are enhanced when daily geomagnetic activity exceeds 15–20 nT", *Neuroscience Letters*, **194**, 69–72.

Quay, W. B. (1974) *Pineal Chemistry*. C. C. Thomas: Springfield (Illinois).

Relkin, R. (1972) "Effects of pinealectomy and constant light and darkness on thyrotropin levels in pituitary and plasma of the rat", *Neuroendocrinology*, **10**, 46–52.

Relkin, R. (1978) "Use of melatonin and synthetic TRH to determine site of pineal inhibition of TSH secretion", *Neuroendocrinology*, **25**, 310–318.

Sandyk, R. & Anninos, P. A. (1992) "Magnetic fields alter the circadian periodicity of seizures", *International Journal of Neuroscience*, **63**, 265–274.

Sandyk, R., Anninos, P. A. & Tsagas, N. (1991) "Age-related disruption of circadian rhythms: possible relationship to memory impairment and implications for therapy with magnetic fields", *International Journal of Neuroscience*, **59**, 259–262.

Van Cauter, E. (1989) Endocrine rhythms. In Arendt J., Minors D. S. and Waterhouse, J. M. (eds.), *Biological rhythms in clinical practice*. (pp. 23–50.) Butterworth, London.

Yaga K., Reiter, R. J., Manchester, L. C., Nieves, H., Sun J-H. & Chen L-D. (1993) "Pineal sensitivity to pulsed static magnetic field changes during the photoperiod", *Brain Research Bulletin*, **30**, 153–156.